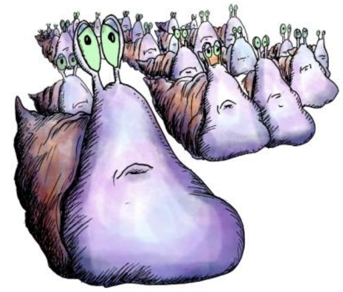
Race for Space: ANS vs. Natives



An introduction to competition

Activity

Students play an interactive game that visually depicts one of the effects aquatic nuisance species may have on an ecosystem.

Grade level: 6-8
Subjects: Ecology, Math, Science
Setting: Classroom
Duration: 50 minutes
Key Terms: competition, generalist, invertebrate, resources, New Zealand mudsnail

Objectives

- Students will understand that resources such as food and space are limiting factors in an ecosystem.
- Students will evaluate how invasive organisms can upset the balance of an ecosystem and out-compete native species for available resources.
- Students will determine the traits that make invasive species so successful in a new ecosystem.
- Students will investigate the biology and physical characteristics of an aquatic nuisance species currently present in the Columbia River – the New Zealand mudsnail.

Materials

- Grid paper (see webpage) or multiple large poster boards with 200-300 cells drawn in a grid.
- Species markers (colored beads)
- Dice

Background

Competition is the interaction between two or more organisms or group of organisms for a common resource that is in short supply. **Resources** are the things that satisfy the needs of living organisms such as food, water, sunlight and physical space (shelter, territory, nesting sites). Competition can occur between two of the same species or two different species. The end result is a reduction in the population of one or both of the organisms and possibly (in the future) a change in the distribution or types of organisms in the ecosystem.

While all species in an ecosystem must compete to survive, invasive species (including aquatic nuisance species) tend to share common characteristics that enable them to out-compete native species for food and preferred habitats.

- Many invasive species are habitat or food generalists, meaning they can live in a wide variety of habitat conditions (or adapt to changing environmental conditions) and consume a broad range of food types.
- Invasive species tend to grow rapidly, reproduce quickly and/or have a high number of offspring.
- Invasive species may compete more aggressively or are more efficient at acquiring important resources than are native species.
- Invasive species often lack natural predators or other population controls (e.g., diseases, parasites) in a new ecosystem so populations can grow out of control more quickly.

Teeny Tiny Trouble – a Case Study: The **New Zealand mudsnail** (NZMS) is a small aquatic snail that is considered an aquatic nuisance species in Australia, Europe, Asia, and North America. As its common name implies, this snail is native to New Zealand and is thought to have been introduced globally through contaminated ballast water or the transport of live fish or eggs for the commercial aquaculture industry. In North America, the NZMS has become established in five Great Lakes states and ten western states including Oregon and Washington. The rapid spread of NZMS within the United States has been attributed to the snail's biological and physical traits. Adult NZMS are tiny, ranging from 3-6 mm in length (see resin specimen). The small size of NZMS makes it difficult to see, increasing the chances of accidentally transporting and introducing the snail to new locations. New Zealand mudsnail can live in a wide range of aquatic ecosystems (e.g., estuaries, rivers, lakes and reservoirs) and can tolerate a fairly broad range of aquatic conditions (e.g., water temperature, salinity, water velocity and substrate types). The broad environmental tolerances of the NZMS enable it to successfully colonize a wide array of aquatic habitats. New Zealand mudsnail populations in the United States are made up entirely of females that reproduce by cloning themselves. Each female may produce 230 offspring per year, and each of those young will become mature at about 8 months of age. If one hitchhiking mudsnail lands in a new ecosystem and produces 230 young, and each of those young reproduce, within one year the stream could have a population of more than 52,900 snail. In some locations, New Zealand mudsnail have been found in densities greater than 300,000 per square meter! Large populations of mudsnail have the potential to completely cover the stream bottom crowding out our displacing native snail, mollusk and benthic aquatic insect species. Dense populations of New Zealand mudsnail can also consume most of the available food base in a stream leaving little for native snails and aquatic insects to feed on. In their native habitat, a trematode parasite keeps NZMS populations at moderate levels. In the United States, the snail has no natural predators so populations can potentially grow out of control. New Zealand mudsnail also have a thick shell wall and rigid operculum or plate that is used to seal off the shell opening. This enables the snail to pass through the digestive tract of predators (such as native fish and waterfowl species) alive and unharmed.

Preparation

- Make a copy of the *Race for Space: ANS vs. Natives Worksheet* for each student or group.
- Before beginning the activity, review common traits of invasive species and provide a brief introduction to the New Zealand mudsnail (see background material).
- Briefly review the instructions of the activity and pass out a copy of the *Race for Space: ANS vs. Natives Worksheet* to each student.
- **Before the Activity:** have the students generate at least two hypotheses to test based on the information they have been given about the species, the landscape and environmental variability. Here are some questions that you might consider:
    - Which species will spread the fastest and why?
    - What will happen when species meet?
    - How will the variation in the environment (rolling the die) affect the colonization?

Directions

- Divide the class into groups of 3 and give each person a set of colored beads (Hint: the person representing the New Zealand mudsnail will need the most beads) and one die. Each colored bead represents an individual of a species and each person within a group will represent one of the species.
- If you are not using graph paper, have each group take a large poster board and draw a 200-300 square grid (make sure each group draws the same number of squares).
- Place one "individual" of each species anywhere on the grid or graph paper.
- Each member of the group takes a turn rolling the die to obtain a number which will represent the variation in environmental conditions that may affect the reproduction of aquatic invertebrates – such as water temperature, flow, food availability and presence of predators. A roll of 1 indicates less suitable conditions while a roll of 6 indicates highly suitable conditions.
- After a group member rolls the die, that number is multiplied by the species reproductive potential (rounded up to the nearest whole number).
    - New Zealand mudsnail has a reproduction potential of 1.3
    - Western pearlshell mussel has a reproductive potential of 1
    - Columbia River pebblesnail has a reproductive potential of 0.5
- The resulting number represents the offspring for each "parent" and that number of beads should be added to the grid adjacent to each parent.
- For example, if the New Zealand mudsnail rolls a 3, then they multiply 3 x 1 (their first individual on the board) x 1.3 = 3.9 and rounded up = 4. Four New Zealand mudsnail beads will be added to the grid for a total of 5 New Zealand mudsnail. In round 2, if the New Zealand mudsnail rolls a 4, they would multiply 4 (environmental suitability) x 5 (individuals on the grid) x 1.3 (reproductive potential) = 26. Twenty-six New Zealand mudsnail beads are added to the board adjacent to any of the other New Zealand mudsnail beads.
- Use the *Race for Space Worksheet* to keep track of your data. Each member of the group (i.e., each species) gets a turn in each round.

- When the grid is full, the game is over.

Evaluation

After the game discuss the following questions:

  - Which species spread across the streambed more quickly? Why?
  - Invasive species compete with native species for resources such as food and living space. Do your results indicate that your aquatic nuisance species was a superior competitor for space?
  - Would you get the same results every time you do the activity? Why or why not?
  - If this exercise were real, what impact could your results have on the river ecosystem? What might happen to each of the species?
  - What factors (environmental or biological) can limit the exponential increase of a population?

Extensions

- Have the students try a different variation of the game and predict how the changes will affect the outcome of the game.
  - Place the very first species in a different location on the board.
  - Try adding geographic obstacles that might limit the spread of the species.
  - At the beginning, put more than one individual of the rare species on the board.
- Use the data gathered on the *Race for Space Worksheet* and piece of graphing paper to make a plot of the population growth for each species (each round could represent 6 months of time). How do the graphs differ from one another?

Source

This activity is an adaption of Competition for Space: Alien vs. Native from the "Educators Guide to Life Along a Prairie River", a project of the Oklahoma Biological Survey.

Washington State Science & Environmental Science Standards:

6-8 INQA – Scientific inquiry involves asking and answering questions and comparing the answer with what scientists already know about the world.

6-8 INQB – Different kinds of questions suggest different kinds of scientific investigations.

6-8 LS2D – Ecosystems are continuously changing. Causes of these changes include nonliving factors such as the amount of light, range of temperatures, and availability of water, as well as living factors such as the disappearance of different species through disease, predation, habitat destruction and overuse of resources or the introduction of new species.

6-8 LS2E – Investigations of environmental issues should uncover factors causing the problem and relevant scientific concepts and findings that may inform an analysis of different ways to address the issue.

6-8 LS3E – Adaptations are physical or behavioral changes that are inherited and enhance the ability of an organism to survive and reproduce in a particular environment.

ESE Standard 1 - Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.

ESE Standard 2; The Natural and Built Environment – Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.

Race for Space: ANS vs. Natives *Worksheet*

Introduction: Your grid represents an artificial aquatic landscape that is ready for colonization by three freshwater invertebrate species. Imagine that your landscape is a small stream bed that was recently scoured by high spring water flows (i.e., spring freshet). Now that flows have dropped, benthic aquatic invertebrates can begin to colonize the empty landscape. The first species to colonize the stream bed is the invasive New Zealand mudsnail. The second species is common to healthy streams in the Pacific Northwest, but doesn't tend to dominate over other species, the western pearlshell mussel. The last species was once common throughout the Columbia River Basin, but now is largely extinct due to habitat modifications and water pollution, the Columbia pebblesnail. The colonization of the stream bed will be based on the reproductive potential of each species and the environmental conditions in the stream.

		New Zealand mudsnail	Western pearlshell	Columbia pebblesnail
1	# of reproducing individuals for Round 1	1	1	1
2	Reproductive Potential	1.3	1.0	0.5
3	Environmental suitability (number from die)			
4	# of individuals added to grid (line 1 x line 2 x line 3)			
5	# of reproducing individuals for Round 2 (line 4 + line 1)			
6	Reproductive Potential	1.3	1.0	0.5
7	Environmental suitability (number from die)			
8	# of individuals added to grid (line 5 x line 6 x line 7)			
9	# of reproducing individuals for Round 3 (line 8 + line 5)			
10	Reproductive Potential	1.3	1.0	0.5
11	Environmental suitability (number from die)			
12	# of individuals added to grid (line 9 x line 10 x line 11)			
13	# of reproducing individuals for Round 4 (Line 12 + line 9)			
14	Reproductive Potential	1.3	1.0	0.5
15	Environmental suitability (number from die)			
16	# of individuals added to grid (line 13 x line 14 x line 15)			
17	# of reproducing individuals for Round 5 (line 16 + line 13)			
18	Reproductive Potential	1.3	1.0	0.5
19	Environmental suitability (number from die)			
20	# of individuals added to grid (line 17 x line 18 x line 19)			
21	# of reproducing individuals for round 6 (line 20 + line 17)			
22	Reproductive Potential	1.3	1.0	0.5
23	Environmental suitability (number from die)			
24	# of individuals added to grid (line 21 x line 22 x line 23)			